FINANCIAL INSTABILITY PREDICTION IN MANUFACTURING AND SERVICE INDUSTRY

Robert Zenzerović[1]

[1]Juraj Dobrila University of Pula, Department of Economics and Tourism "Dr. Mijo Mirković", Croatia, robert.zenzerovic@efpu.hr

Abstract

This article presents an attempt to derive models for financial instability prediction in manufacturing and service industry especially suitable for transitional environments. Research results indicate that the most important ratios – independent variables that discriminate financially stable from unstable companies consist of liquidity, solvency and profitability ratios. Financial instability models have high degree of diagnostic and prognostic power what was statistically validated on the sample units. Aforementioned predictive ability makes these models appropriate tools for predicting the degree of financial stability of company's business partners as well as useful instrument in estimating the appropriateness of going concern assumption for company itself. Financial instability models can be used, not only as instrument for choosing adequate business partners, but also as a tool for estimating the level and trends of financial stability in manufacturing and service industry on macro level presenting in this way instrument for macro policy decision makers.

JEL classification: G33, O16

Keywords: Financial crisis, bankruptcy, loss above equity, financial instability prediction models, discriminant analysis, manufacturing and service industry

1. INTRODUCTION

Financial instability is immanent to modern economies where business entities are operating in rapidly changeable and instable environment. In order to handle with rising level of different business risks that are often resulting in financial instability and sometimes in business liquidation, researcher are trying to develop quantitative models able to predict financial instability. The modern history of business' financial instability prediction started in the second half of last century in the United States with usage of univariate statistical methods (Beawer, 1966, 71). Altman, the most known researcher in this field introduced the implementation of multivariate statistics in this field of financial analysis and derived the Z-score, widely known bankruptcy prediction model (Altman, 1968, 594). The other much known researchers in this area are Deakin (Deakin,

1972), Edminster (Edminster, 1972) and Ohlson (Ohlson, 1980) who tried to estimate the models suitable for different branches and companies' sizes.
Most of the researches in this area were done in developed countries with long tradition of free market economy and stability of the legal system. In transitional environment like Croatia the institutions, the way they are working, and rules are quite different from developed countries, as well as basic values in the society as a whole, so simple application of models derived in developed countries is not adequate (Deverić, 2002, Škeljo, 2000). In this sense some authors like Belak & Aljinović Barać (Belak, Aljinović Barać, 2007, 18) and Novak & Crnković (Novak, Crnković, 2007) developed models applicable in transitional countries by using different criteria for discriminating financially stable from unstable companies. The research presented in further text is particular by criteria set for discriminating stable from unstable companies, sample design which is representing the structure of Croatian economy and quite long reporting period for data collected.

2. RESEARCH HYPOTHESYS AND METHODOLOGY

Scientific approach in estimating the financial instability include various steps that has to be done in order to get model that is based on scientifically research that employs appropriate scientific methods (Westgaard, 2005, 4).
The objective of the research performed was to carry out the financial instability prediction models for manufacturing and service industry. In this sense, at the very beginning, the further research hypothesis was set: Financial instability in manufacturing and service industry could be reasonably estimated in the two years period by using the combination of various financial ratios.
Different scientific methods were used in this research, but the central role was captured by statistical method known as multiple discriminant analysis (in the further text MDA). This statistical method represent a special type of regression analysis that identify the independent variables that best discriminate the sample units according to their selected characteristics that are dichotomous and it was found to be very useful technique for discriminating the financially stable from unstable companies. The result of MDA is discriminant function that consists of selected independent variables and discriminant coefficients.
Independent variables in research consist of 50 financial ratios that represent liquidity and solvency ratio, activity, profitability and investment ratios as well as ratio based on cash flow statement. On the other side of equation was dichotomous dependent variable which represents the state of financial stability of chosen company. Financially stable company had the value 1, while those unstable i.e. those who went bankrupt or disclosed loss above equity had the value 0.

3. EMPRICAL RESEARCH IN TRANSITIONAL ENVIRONMENT – CROATIAN CASE

The research results presented in this article are an attempt to derive models for financial instability prediction in manufacturing and service industry especially suitable for transitional environments where institutions, i.e. the way they are working, and rules are quite different from developed countries, as well as basic values in the society as a whole. Models were carried out as a result of scientific research among Croatian companies in period from 1996 to 2006.

3.1. Sample design

The starting point in the research was setting the research objective and hypothesis. In the second step, sample has to be designed in order to reach the conclusion that can be applied to whole population. Population consists of all active business entities in the Republic of Croatia. The sample was designed in order to represent, closely as possible, population having in mind limitation of research methodology for companies operating in particular branches like financial or public sector. These branches were not examined because the usage of specific financial ratios is typical for their analysis. The final sample consists of 110 business entities where 68 entities operated in manufacturing industry, which consist of manufacturing and construction, while 42 companies were doing business in service industry i.e. traffic, warehousing, communications, hotels and restaurants. In sample design the attention was given to companies' size as well, so the final sample represents the population according to the criterion of companies' size. The sample includes 55 financially stable and 55 financially unstable companies where those unstable were considered those that went bankrupt or had disclosed loss above equity. Table 1 shows the structure of final sample.

Table 1. Final sample structure

Activities	Size			Total
	Small	Medium	Big	
Manufacturing	19	26	23	**68**
Financially stable companies	10	11	12	**33**
Financially unstable companies	9	15	11	**35**
Service industry	7	17	18	**42**
Financially stable companies	4	8	10	**22**
Financially unstable companies	3	9	8	**20**
Total	**26**	**43**	**41**	**110**

Source: Author's calculation

After designing the sample according to companies' size and activities, in the next step the accounting data from financial statements has to be collected. The data were collected from the Financial agency data base as well as from publicly disclosed financial statements on Zagreb stock exchange. The information regards different positions from financial statements that are collected for the year before the company went bankrupt or disclosed loss above equity. On the other side the same data for the same period were collected for financially stable companies. In the situations where company that went bankrupt had loss above equity in the appropriate year, the data were collected for the year before the loss above equity was obtained. Accounting data were used for calculation of 50 financial ratios that were inputted in SPSS software used to perform MDA.

3.2. Financial instability model estimation for manufacturing companies

The subsample of manufacturing companies consists of 68 companies that were doing business in manufacturing and construction. 33 of these companies were financially stable while other 35 of them was treated financially unstable according to fact that they went bankrupt or disclosed loss above equity. Financial ratios calculated for these companies were inputted in the SPSS software and MDA were done. The result of MDA is the FIP_{manuf} model, shown in equation 1, which represents the combination of constant and five independent variables multiplied by appropriate unstandardized coefficients.

$$FIP_{manuf} = -2{,}721 + 2{,}063\,RK/I - 0{,}008FZ + 4{,}633A + 2{,}74EUP + 1{,}665ROA \quad (1)$$

The model is derived after the autocorrelated independent variables i.e. those that had correlation ratio higher than 0,8, as well as statistically nonsignificant variables were excluded. Relative importance of each independent variable in discriminant power of function is shown by standardized coefficients, while structure coefficients represent correlation between independent variable and value of discriminant function (table 2). Definition of selected discriminant function coefficients is very important when making the decision on which independents to exclude from function in order to make model more efficient and easy to use. Namely, model is efficient and easy to use when there is reasonable number of independent variables included in its calculation.

Table 2. Selected discriminant function coefficients – FIP_{manuf} model

Independent variable	Structure coefficients	Standardized discriminant function coefficients	Unstandardized discriminant function coefficients
Working capital/Total assets (***RK/I***)	,519	,477	2,063
Total liabilities/(Retained earnings + depreciation) (***FZ***)	-,317	-,527	-,008
Retained earnings/Total assets (***A***)	,595	,454	4,633
Total revenues/Total expenses (***EUP***)	,446	,519	2,74
Return on assets (***ROA***)	,501	,168	1,665
(Constant)	-	-	-2,721

Source: Author's calculation

Important elements of discriminant function quality are presented in table 3. Low Wilks' lambda with 0,00 significance indicates that independent variables included in model significantly discriminate financially stable from unstable companies. The other important quality coefficient, canonical correlation, has value of 0,805 what means that 80,5% variations of dependent variable is discriminated by the set of independents i.e. discriminant function what is at acceptable level.

Table 3. Selected discriminant function quality coefficients – FIP_{manuf} model

Eigenvalues				
Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	1,846	100,0	100,0	,805
Wilks' Lambda				
Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	,351	64,319	5	,000

Source: Author's calculation

Next step in the MDA is analysis of FIP_{manuf} model classification ability what is one of the most important model characteristics. Classification is done for period of one year prior to bankruptcy or disclosure of loss above equity for financially unstable companies and for the same period for financially stable ones. The value of the model for each company is calculated and compared with model critical value of - 0,000061 (equation 2). If the value of the model for particular company is lower or equal to critical value, the company is treated as financially unstable and vice versa.

$$CV = \frac{(-1{,}298 \times 34) + (1{,}379 \times 32)}{66} = -0{,}000061 \qquad (2)$$

FIP_{manuf} model classification results are shown in table 4. The results show that 95,5% of original units are correctly classified and the result is the same for cross section analysis. Cross section analysis is an alternative for testing the model classification accuracy by using the so called hold-out sample. This classification analysis is performed in a way it calculates the classification of the sample unit using the discriminant function derived from all other units from the sample.

Table 4. Classification results – FIP_{manuf} model

Financial stability			Prior probabilities for group		Total
			Unstable	Stable	
Original	Count	Unstable	32	2	34
		Stable	1	31	32
	%	Unstable	94,1	5,9	100,0
		Stable	3,1	96,9	100,0
Cross-validated	Count	Unstable	32	2	34
		Stable	1	31	32
	%	Unstable	94,1	5,9	100,0
		Stable	3,1	96,9	100,0

Source: Author's calculation

a Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.
b 95,5% of original grouped cases correctly classified.
c 95,5% of cross-validated grouped cases correctly classified.

High predictive ability of the FIP_{manuf} model in the period of one year prior to bankruptcy or loss above equity disclosure has been extended by testing the model predictive characteristics in a two year run. The results indicate that the model predictive ability decreased to 81,7% but it is still at acceptable level. The conclusion on classification results acceptance can be done by comparing particular classification results with theoretical probability increased by 25%. Theoretical probability for two equal groups is 50%, while in the case the groups' sizes are different it can be calculated by using the equation 3 where p represent proportion in group 1, and $1 - p$ proportion in group 2.

$$P_{sluc} = p^2 + (1 - p)^2 \quad (3)$$

Other important elements in classification results analysis are classification errors. Type 1 error appears in the situations where model classify financially unstable company as a healthy one, while type 2 error appears in opposite situations. In one year period prior to bankruptcy or loss above equity disclosure the type 1 error appearance is 5,9% versus type 2 error of 3,1%. The classification ability of the model decreased in two year period prior to bankruptcy or loss above equity disclosure as consequence of quite high type 1 error that reach 35,5%, while the model did not score type 2 error.

3.3. Financial instability model estimation in service industry

Second part of analysis consists of deriving the financial instability model appropriate for service industry. Subsample of companies that operated in service industry consists of 41 business entities. 19 of these companies went bankrupt or disclosed loss above equity, while others were financially stable. MDA were done using the 50 financial ratio calculated for mentioned subsample. Final result of MDA is FIP_{serv} model that is presented in equation 4. Financial instability prediction model consists of constant and three independent variables multiplied by adequate unstandardized coefficients. These coefficients, as well as structure and standardized discriminant function coefficients are shown in table 5. The highest relative importance in discriminant power of model has ratio Total revenues/total expenses, while the ratio Working capital/total assets has the strongest correlation with the value of discriminant function.

$$FIP_{serv} = -2{,}627 + 2{,}316\,RK/I + 2{,}663A + 2{,}583EUP \quad (4)$$

Table 6 shows selected discriminant function quality coefficients. Relatively low Wilks' lambda with 0,00 significance indicates that independent variables included in model significantly discriminate financially stable from unstable companies. Canonical correlation, has value of 0,735 what means that 73,5% variations of dependent variable is discriminated by the set of independents i.e. discriminant function what can be estimated as acceptable.

Table 5. Selected discriminant function coefficients – FIP_{serv} model

Independent variable	Structure coefficients	Standardized discriminant function coefficients	Unstandardized discriminant function coefficients
Working capital/Total assets (***RK/I***)	,823	,492	2,316
Retained earnings/Total assets (***A***)	,541	,312	2,663
Total revenues/Total expenses (***EUP***)	,699	,610	2,583
(Constant)	-	-	-2,627

Source: Author's calculation

Table 6. Selected discriminant function quality coefficients – FIP_{serv} model

Eigenvalues				
Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	1,173	100,0	100,0	,735
Wilks' Lambda				
Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	,46	29,1	3	,000

Source: Author's calculation

Classification results (table 7) are calculated by comparing the model's value of particular company with critical value 0,000024 (equation 5). The results indicate that FIP_{serv} model correctly classified 90,2% of sample units in the period of one year prior to bankruptcy or loss obove equity disclosure, while in the two year period classification ability have decreased to 85,5%. Errors analysis emphasize the higher level of type 1 error which is 15,8% in one year period and 28,6% in two year period prior to bankruptcy or loss above equity disclosure.

$$CV = \frac{(-1{,}137 \times 19) + (0{,}982 \times 22)}{41} = 0{,}000024 \qquad (5)$$

4. CONCLUSION

Financial instability estimation became particularly actual in nowadays when global economy is facing one of the biggest crisis after world war two. The research performed among Croatian companies proved the hypothesis that financial instability in manufacturing and service industry could be reasonably estimated in the two years period by using the combination of various financial ratios. Liquidity, solvency and profitability ratios were found to be statistically most significant in distinguishing stable from unstable companies. Implementation of MDA resulted in derivation of two financial instability prediction models. Both models show high degree of predictive accuracy which is particularly emphasized in the period of one year prior to bankruptcy or loss above equity, while in the two years run it is lower but still at acceptable level. Analysis of type 1 and 2 errors shows higher appearance of type 1 error what refer to higher degree of misclassification of financially unstable companies.

Table 7. Classification results – FIP_{serv} model

Financial stability			Prior probabilities for group		Total
			Unstable	Stable	
Original	Count	Unstable	16	3	19
		Stable	1	21	22
	%	Unstable	84,2	15,8	100,0
		Stable	4,5	95,5	100,0
Cross-validated	Count	Unstable	16	3	19
		Stable	1	21	22
	%	Unstable	84,2	15,8	100,0
		Stable	4,5	95,5	100,0

Source: Author's calculation

a Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.

b 90,2% of original grouped cases correctly classified.

c 90,2% of cross-validated grouped cases correctly classified.

Presented discriminant quality coefficients as well as classification results indicate that the models are appropriate for financial instability prediction in manufacturing and service industry. These models can find wide area of practical applications, from micro application i.e. application on the level of particular company, to macro level i.e. the level of manufacturing and service industry presenting in this way useful instrument for macro policy decision makers. Application of the models in transitional real world environment

should verify their discriminating ability and make a starting point for their improvement and enlargement in the future researches.

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